REMARKS

I. Introduction

By the present Amendment, claims 1, 2, and 4-6 have been amended. Claim 3 has been cancelled. Accordingly, claims 1, 2, and 4-6 remain pending in the application. Claims 1, 2, and 4-6 are independent.

II. Office Action Summary

In the Office Action of March 17, 2008, claims 1-6 were rejected under 35 USC §102(e) as being anticipated by U.S. Patent Application No. 2005/0033153 to Moriguchi et al. ("Moriguchi"). Claims 1-6 were also rejected under 35 USC §102(e) as being anticipated by U.S. Patent No. 7,042,215 to Moriguchi et al. (subsequently issued patent). In concert with the Office Action, only the published application will be addressed. Claims 1-6 were provisionally rejected on the ground of non-statutory double patenting over claims 1-11 of copending Application No. 11/630,766 to Hirata et al. ("Hirata").

The cancellation of claim 3 has rendered part of these grounds of rejection moot. Regarding the remaining claims, these rejections are respectfully traversed.

III. Interview

Applicants would like to thank Examiners Fetzner and Shrivastav for the courtesy and cooperation extended during the interview of July 15, 2008. During the interview, Applicants discussed the claimed invention and, in particular, the features that were believed to be novel over Moriguchi. Applicants indicated that the claimed invention is capable of performing various functions/calculations while the MRI data is being acquired. While no agreements regarding claim amendments were

reached, it was agreed that Applicants' discussion of the invention suggested that differences appeared to exist with respect to Moriguchi. However, the Examiner indicated that the claims were not written in such a manner as to clearly identify such features. Applicants agreed that the claims would be amended to better define the invention and provide some clarity as to the point in time when certain functions are performed.

IV. Rejections under 35 USC §102

Claims 1-6 were rejected under 35 USC §102(e) as being anticipated by Moriguchi. In rejecting claim 1, the Office Action asserts that Moriguchi discloses a magnetic resonance imaging system that comprises all of the features recited therein. For example, the Office Action alleges that Moriguchi discloses a sequence control means that includes control to irradiate the target wit RF magnetic field; measure the magnetic resonance signal generated after the irradiation of the RF magnetic field in a state in which the strength of the application of the gradient magnetic field is approximately zero, and to calculate magnetic resonance spectrum information from the measured magnetic resonance signal to thereby perform a magnetic resonance spectrum measurement. The Office Action directs reference to Figs. 1 and 9, paragraphs [0007] to [0014], and paragraphs [0082] to [0084]. The Office Action further asserts that Moriguchi calculates a time-varying rate of the magnetic resonant frequency of water on the basis of F1 and F2. Applicants respectfully disagree.

By the present Amendment, Applicants have amended the pending claims to better define the invention and identify features that are not shown or suggested by

the art of record. As amended, independent claim 1 defines a magnetic resonance imaging system that comprises:

> means for generating a static magnetic field;
>
> gradient magnetic field generating means for generating a gradient magnetic field;
>
> RF magnetic field generating means for generating an RF magnetic field;
>
> measuring means for measuring a magnetic resonance signal generated from a target;
>
> computing means configured to perform a computation on the magnetic resonance signal;
>
> memory means for storing the magnetic resonance signal and the result of computation by the computing means; and
>
> sequence control means configured to set operating conditions to respective portions of the gradient magnetic field generating means, the RF magnetic field generating means, the measuring means, the computing means and the memory means;
>
> said sequence control means being configured to:
>
> (1) measure a first magnetic resonance signal generated from a measurement voxel at the magnetic resonance spectrum measurement at a first time interval,
>
> (2) detect a magnetic resonant frequency F1 of water from a first magnetic resonance spectrum obtained by Fourier-transforming the first magnetic resonance signal,
>
> (3) measure a second magnetic resonance signal generated from the voxel at a second time interval subsequent to the elapse of a predetermined time from the measurement of the first magnetic resonance signal,
>
> (4) detect a magnetic resonant frequency F2 of water from a second magnetic resonance spectrum obtained by Fourier-transforming the second magnetic resonance signal,
>
> (5) calculate a time-varying rate of the magnetic resonant frequency of water based on the detected F1 and detected F2,
>
> (6) set, based on the calculated time-varying rate of the magnetic resonant frequency of water, a transmission frequency of the RF magnetic field radiated into the target or/and a received frequency, and
>
> (7) measure a magnetic resonance signal a predetermined number of times using the set transmission frequency of the RF magnetic field and/or the set received frequency.

The magnetic resonance imaging system of independent claim 1 includes means for generating a static magnetic field, a gradient magnetic field generating means for generating a gradient magnetic field, an RF magnetic field generating system for generating an RF magnetic field, measuring means for measuring a magnetic resonance signal generated from a target, computing means configured to perform a computation on the magnetic resonance signal, and a memory means for storing the magnetic resonance signal and the result of the computation. The magnetic resonance imaging system also includes a sequence control means that is configured to set the various operating conditions of the gradient magnetic field generating means, RF magnetic field generating means, measuring means, computing means, and memory means.

According to independent claim 1, the sequence control means is also configured to measure a first magnetic resonance signal that is generated from a measurement voxel at the magnetic resonance spectrum measurement during a first time interval. Next, a magnetic resonant frequency (F1) of water is detected from a first magnetic resonance spectrum that is obtained by Fourier-transforming the first magnetic resonance signal. A second magnetic resonance signal generated from the voxel is measured from the first magnetic resonance signal at a second time interval after a predetermined amount of time has elapsed. A second magnetic resonant frequency (F2) of water is detected from a second magnetic resonance spectrum obtained by Fourier-transforming the second magnetic resonance signal.

A time-varying rate of the magnetic resonant frequency of water is calculated based on the detected values of the magnetic resonant frequencies (F1 and F2). Based on the calculated time varying rate of the magnetic resonant frequency of water, a transmission frequency of the RF magnetic field radiated into the target

and/or a received frequency is set. The first and second magnetic resonant signals are then measured a predetermined number of times using the set transmission frequency of the RF magnetic field and/or the set received frequency. Thus, according to independent claim 1, the time-varying rate of the magnetic resonance frequency is calculated and applied to set the transmission frequency of the RF magnetic field and/or the received frequency for measuring subsequent first and second magnetic resonance signals.

The Office Action alleges that Moriguchi discloses all of the features recited in independent claim 1, including the calculation and use of a time-varying rate of the magnetic resonant frequency of water. This does not appear to be the case. According to Moriguchi, the frequency map images contain blurring artifacts that must be removed by a deblurring process. Accordingly, the deblurring is statically performed based on the calculated frequency map. See paragraph [0038]. Furthermore, the deblurring calculations utilize the frequency shift (Φ), and signals at each pixel in the reconstructed images from the data sets (S0, S1, S2). See paragraphs [0031], [0035], and [0036]. Applicants note that none of these values corresponds to the actual magnetic resonance frequency.

While Moriguchi discloses the use of multiple demodulation frequencies, these frequencies are not time-varying. Rather, these frequencies are obtained from the original frequency maps. Two parallel operations are performed wherein one process generates a deblurred water image from the acquired data while the other process generates a deblurred fat image from the acquired data. See paragraph [0033]. The demodulation frequencies used to deblur the water image are the same frequencies indicated in the frequency map, while the demodulation frequencies used to deblur the fat image are the sum of the chemical-shift off-resonance

frequency and local frequencies that are indicated on the same frequency map. See paragraph [0038].

Furthermore, Moriguchi is completely silent on first detecting two different magnetic frequencies at different time intervals in order to calculate a time varying rate of the magnetic resonant frequency of water. Furthermore, Moriguchi is completely silent on setting the transmission frequency and/or the receive frequency based on the time varying rate of the magnetic resonant frequency of water that has been calculated in order to perform subsequent measurements of the first and second magnetic resonant signals. Thus, Moriguchi fails to provide any disclosure or suggestion for features recited in independent claim 1, such as:

...

> (1) measure a first magnetic resonance signal generated from a measurement voxel at the magnetic resonance spectrum measurement at a first time interval,
>
> (2) detect a magnetic resonant frequency F1 of water from a first magnetic resonance spectrum obtained by Fourier-transforming the first magnetic resonance signal,
>
> (3) measure a second magnetic resonance signal generated from the voxel at a second time interval subsequent to the elapse of a predetermined time from the measurement of the first magnetic resonance signal,
>
> (4) detect a magnetic resonant frequency F2 of water from a second magnetic resonance spectrum obtained by Fourier-transforming the second magnetic resonance signal,
>
> (5) calculate a time-varying rate of the magnetic resonant frequency of water based on the detected F1 and detected F2,
>
> (6) set, based on the calculated time-varying rate of the magnetic resonant frequency of water, a transmission frequency of the RF magnetic field radiated into the target or/and a received frequency, and
>
> (7) measure a magnetic resonance signal a predetermined number of times using the set transmission frequency of the RF magnetic field and/or the set received frequency.

It is therefore respectfully submitted that independent claim 1 is allowable over the art of record.

Independent claim 2 defines a magnetic resonance imaging system that comprises:

> means for generating a static magnetic field;
>
> gradient magnetic field generating means for generating a gradient magnetic field;
>
> RF magnetic field generating means for generating an RF magnetic field;
>
> measuring means for measuring a magnetic resonance signal generated from a target;
>
> computing means configured to perform a computation on the magnetic resonance signal;
>
> memory means for storing the magnetic resonance signal and the result of computation by the computing means; and
>
> sequence control means configured to set operating conditions to respective portions of the gradient magnetic field generating means, the RF magnetic field generating means, the measuring means, the computing means and the memory means to control the operations of the respective portions,
>
> said sequence control means being configured to:
>
> (1) measure a first magnetic resonance signal generated from a measurement voxel at the magnetic resonance spectrum measurement at a first time interval,
>
> (2) detect a magnetic resonant frequency F1 of water from a first magnetic resonance spectrum obtained by Fourier-transforming the first magnetic resonance signal,
>
> (3) measure a second magnetic resonance signal generated from the voxel at a second time interval subsequent to the elapse of a predetermined time from the measurement of the first magnetic resonance signal,
>
> (4) detect a magnetic resonant frequency F2 of water from a second magnetic resonance spectrum obtained by Fourier-transforming the second magnetic resonance signal,
>
> (5) estimate, based on the detected F1 and detected F2, a time-varying rate of a magnetic resonant frequency of water at a measurement time at which the magnetic resonance signal is measured after the completion of measurement of the second magnetic resonance signal,

(6) calculate, using the estimated time-varying rate of the magnetic resonant frequency, a transmission frequency of the RF magnetic field or/and a received frequency at which the magnetic resonance signal generated from the voxel is received, and

(7) measure the magnetic resonance signal generated from the voxel a predetermined number of times using the calculated transmission frequency of the RF magnetic field and/or the calculated received frequency.

According to various features of independent claim 2, a magnetic resonant frequency of water is detected from a first magnetic resonance spectrum as well as a second magnetic resonance spectrum. These two magnetic resonance frequencies are used to estimate a time varying rate of the magnetic resonant frequency of water so that a transmission frequency of the RF magnetic field and/or a receive frequency can be set where the magnetic resonant signal generated from the voxel is received. Furthermore, the calculated transmission frequency of the RF magnetic field or the calculated received frequency is used while measuring subsequent magnetic resonance signals generated from the voxel a predetermined number of times. As previously discussed with respect to independent claim 1, Moriguchi fails to provide any disclosure or suggestion for calculating and using a time-varying rate of the magnetic resonant frequency of water, and using this value to set the transmission and/or receive frequencies for subsequent measurements of the magnetic resonance signal. Accordingly, Moriguchi fails to disclose features recited in independent claim 2, such as:

...

(5) estimate, based on the detected F1 and detected F2, a time-varying rate of a magnetic resonant frequency of water at a measurement time at which the magnetic resonance signal is measured after the completion of measurement of the second magnetic resonance signal,

(6) calculate, using the estimated time-varying rate of the magnetic resonant frequency, a transmission frequency of the RF magnetic field or/and a received frequency at which the magnetic resonance signal generated from the voxel is received, and

(7) measure the magnetic resonance signal generated from the voxel a predetermined number of times using the calculated transmission frequency of the RF magnetic field and/or the calculated received frequency.

As amended, independent claim 4 defines a magnetic resonance imaging system that comprises, in part:

sequence control means configured for setting operating conditions to respective portions of the gradient magnetic field generating means, the RF magnetic field generating means, the measuring means, the computing means, and the memory means;

said sequence control means being configured to:

(1) execute one or more pres-scans for measuring a magnetic resonant frequency of water,

(2) detect a magnetic resonant frequency of water from a magnetic resonance spectrum obtained by Fourier-transforming the magnetic resonance signal obtained by a current pre-scan,

(3) set, based on the magnetic resonant frequency of water detected in said (2), a transmission frequency of the RF magnetic field radiated into the target or/and a received frequency, and

(4) measure the magnetic resonance signal a predetermined number of times for each of the one or more pre-scans using the set transmission frequency of the RF magnetic field and/or the set received frequency.

According to various features of independent claim 4, a sequence control means is configured for setting operating conditions for a gradient magnetic field generating means, an RF magnetic field generating means, a measuring means, a computing means, and a memory means. Furthermore, the sequence control means is configured to execute one or more pre-scans for measuring a magnetic resonant frequency of water, and detecting a magnetic resonant frequency of the water from a magnetic resonance spectrum obtained by Fourier-transforming the magnetic

resonance signal obtained by a current pre-scan. Next, a transmission frequency of the RF magnetic field is radiated into the target and/or a receive frequency is set based on the detected magnetic resonant frequency of water. Finally, the magnetic resonance signal is measured a predetermined number of times for each of the one or more pre-scans using the set transmission frequency of the RF magnetic field and/or the set received frequency. Thus, according to independent claim 4, each time a pre-scan is executed, the transmission frequency and/or received frequency is calculated based on the detected magnetic resonant frequency of water. The transmission frequency and/or receive frequency are used so that the magnetic resonant signal can be measured a predetermined number of times for each pre-scan.

The Office Action had previously indicated that Moriguchi disclosed all the features of independent claim 4. The present amendments, however, have better clarified the language of independent claim 4 and further incorporated features that were not previously recited. Applicants' review of Moriguchi, however, has not revealed any disclosure or suggestion for setting the transmission frequency and/or receive frequency based on the magnetic resonant frequency of water detected from a pre-scan, and applying the transmission frequency and receive frequency to subsequently measure the magnetic resonance signal a predetermined number of times for each individual pre-scan. More particularly, Moriguchi does not appear to provide any disclosure or suggestion for features recited in independent claim 4, such as

...

(1) execute one or more pres-scans for measuring a magnetic resonant frequency of water,

(2) detect a magnetic resonant frequency of water from a magnetic resonance spectrum obtained by Fourier-transforming the magnetic resonance signal obtained by a current pre-scan,

(3) set, based on the magnetic resonant frequency of water detected in said (2), a transmission frequency of the RF magnetic field radiated into the target or/and a received frequency, and

(4) measure the magnetic resonance signal a predetermined number of times for each of the one or more pre-scans using the set transmission frequency of the RF magnetic field and/or the set received frequency.

It is therefore respectfully submitted that independent claim 4 is allowable over the art of record.

As amended, independent claim 5 defines a magnetic resonance imaging system that comprises, in part:

sequence control means configured to set operating conditions to respective portions of the gradient magnetic field generating means, the RF magnetic field generating means, the measuring means, the computing means and the memory means,

said sequence control means being configured to:

(1) execute one or more pre-scan sequences for measuring a magnetic resonant frequency of water,

(2) set, based on the measured magnetic resonant frequency of water, a transmission frequency of the RF magnetic field irradiated in a water suppression sequence and a transmission frequency of the RF magnetic field irradiated to select and excite a predetermined voxel or/and a received frequency at a detection of a magnetic resonance signal generated from the predetermined voxel in a spectrum measurement sequence,

(3) execute the water suppression sequence for applying the RF magnetic field and the gradient magnetic field to the target to thereby suppress a signal of water, and

(4) execute the spectrum measurement sequence for applying the RF magnetic field and the gradient magnetic field to the target to select and excite a predetermined voxel and measuring the magnetic resonance signal generated from the predetermined voxel,

wherein the water suppression sequence and the spectrum measurement sequence are executed a predetermined number of times for each of the one or more pre-scan sequences.

According to various features of independent claim 5, the sequence control means is configured to execute one or more pre-scan sequences for measuring a magnetic resonant frequency of water. Based on the measured magnetic resonant frequency of water, the sequence control means sets a transmission frequency of the RF magnetic field irradiated in a water suppression sequence and a transmission frequency of the RF magnetic field irradiated to select and excite a predetermined voxel. A receive frequency is also set at a detection of a magnetic resonance signal generated from the predetermined voxel in a spectrum measuring sequence. Next, the water suppression sequence is executed for applying the RF magnetic field and the gradient magnetic field to the target to thereby suppress the signal of water. The spectrum measurement sequence is executed to apply the RF magnetic field and the gradient magnetic field to the target in order to select and excite the predetermined voxel, and also to measure the magnetic resonant signal generated from the predetermined voxel. According to independent claim 5, the water suppression sequence in the spectrum measurement sequence are executed a predetermined number of times for each of the one or more pre-scan sequences. Thus, the set frequencies are applied when subsequent water suppression and spectrum measurement sequences are executed.

As previously discussed, Moriguchi does not appear to set the transmission and receive frequencies that can be applied to subsequent processes in order to determine the magnetic resonance signal. Furthermore, Moriguchi does not appear to disclose features such as execution of the water suppression sequence and the spectrum measurement sequence a predetermined number of times for each pre-scan sequence.

It is therefore respectfully submitted that independent claim 5 is allowable over the art of record.

As amended, independent claim 6 defines a magnetic resonance imaging system that comprises, in part:

> sequence control means configured to set operating conditions to respective portions of the gradient magnetic field generating means, the RF magnetic field generating means, the measuring means, the computing means and the memory means,
>
> said sequence control means being configured to:
>
> (1) execute a water suppression sequence for applying the RF magnetic field and the gradient magnetic field to the target to thereby suppress a signal of water,
>
> (2) execute a spectrum measurement sequence for applying the RF magnetic field and the gradient magnetic field to the target to select and excite a predetermined voxel and measuring the magnetic resonance signal generated from the predetermined voxel,
>
> (3) executed the water suppression sequence and the spectrum measurement sequence a predetermined number of times to detect a water signal peak from a magnetic resonance spectrum obtained by Fourier-transforming the measured magnetic resonance signal. and calculate a signal strength of the water signal peak,
>
> (4) determine that a magnetic resonant frequency of water has been shifted when the calculated signal strength of the water signal peak is increased to a predetermined value or more,
>
> (5) execute a pre-scan for measuring the water magnetic resonant frequency when the water magnetic resonant frequency is judged to have been shifted in said (4),
>
> (6) detect a magnetic resonant frequency of water from a magnetic resonance spectrum obtained by Fourier-transforming the magnetic resonance signal obtained in the pre-scan, and
>
> (7) set, based on the detected magnetic resonant frequency of water, set a transmission frequency of the RF magnetic field irradiated in a further water suppression sequence, or/and set a transmission frequency of the RF magnetic field irradiated to select and excite the predetermined voxel in a further spectrum measurement sequence, or/and set a received frequency at the detection of the magnetic resonance signal generated from the predetermined voxel,
>
> wherein the further water suppression sequence and the further spectrum measurement sequence are executed subsequent to the pre-scan.

According to some of the features of independent claim 6, a water suppression sequence is executed for applying the RF magnetic field and the gradient magnetic field to the target in order to suppress the water signal. A spectrum measuring sequence is executed to apply the RF magnetic field and the gradient magnetic field to the target to select and excite a predetermined voxel and measure the magnetic resonance signal generated from the predetermined voxel. The water suppression sequence and the spectrum measurement sequence are executed a predetermined number of times in order to detect a water signal peak from the magnetic resonance spectrum obtained by Fourier-transforming the measured magnetic resonance signal, and a signal strength is calculated at the water signal peak. Next, the sequence control means determines if the magnetic resonant frequency of water has been shifted. Such a shift occurs when the calculated signal strength of the water signal peak has increased to a predetermined value or higher. A pre-scan is executed to measure the water magnetic resonant frequency when it is determined to have been shifted. A magnetic resonant frequency of water is detected from a magnetic resonance spectrum obtained by Fourier-transforming the magnetic resonant signal obtained in the pre-scan. Based on the detected magnetic resonant frequency of water, a transmission frequency of the RF magnetic field irradiated in a further water suppression sequence is set. A transmission frequency of the RF magnetic field irradiated to select and excite the predetermined voxel in a further spectrum measurement sequence is also set. Additionally, the received frequency at the detection of the magnetic resonance signal generated from the predetermined voxel is also set. According to independent claim 6, the further water suppression sequence and the further spectrum measurement sequence are <u>executed after the pre-scan</u> has been executed.

Accordingly, the detected magnetic resonant frequency of water obtained in the pre-scan is used to set the frequencies that are applied when a subsequent water suppression sequence and spectrum measurement sequence are executed.

As previously discussed, Moriguchi fails to provide any disclosure or suggestion for such features, including setting the transmission and receive frequencies of subsequent measurement sequences based on calculation of the current measurement sequences. It is therefore respectfully submitted that independent claim 6 is allowable over the art of record.

V. Double Patenting Rejections

Claims 1-6 were provisionally rejected on the ground of non-statutory double patenting over claims 1-11 of Hirata. Concurrently submitted herewith, is a Terminal Disclaimer which disclaims the terminal portion of any patent issued from the current application.

Withdrawal of this rejection is therefore respectfully requested.

VI. Conclusion

For the reasons stated above, it is respectfully submitted that all of the pending claims are now in condition for allowance. Therefore, the issuance of a Notice of Allowance is believed in order, and courteously solicited.

If the Examiner believes that there are any matters which can be resolved by way of either a personal or telephone interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

RECEIVED
CENTRAL FAX CENTER

AUG 1 8 2008

Docket No. 520.45750X00
Serial No. 10/562,643
Office Action dated March 17, 2008

AUTHORIZATION

Applicants request any shortage or excess in fees in connection with the filing of this paper, including extension of time fees, and for which no other form of payment is offered, be charged or credited to Deposit Account No. 01-2135 (Case: 520.45750X00).

Respectfully submitted,
ANTONELLI, TERRY, STOUT & KRAUS, LLP.

Leonid D. Thenor
Registration No. 39,397

LDT/vvr
1300 N. Seventeenth Street
Suite 1800
Arlington, Virginia 22209
Tel: 703-312-6600
Fax: 703-312-6666

Dated: August 18, 2008